Space Weather Technical Forecast

Issued on Monday, 22 April 2024 at 13:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares expected (R1/R2 blackouts). Slight chance of isolated G1/Minor Storm intervals from peripheral CME effects.

IMPORTANT NOTICE: On the 23rd of April between 1500 UTC and 2100 UTC, a significant data outage at NOAA SWPC is expected which will impact most of our observational data feeds and some models. We may receive data intermittently through that period. MOSWOC service will continue on contingency. Alerts and warnings will be sent using alternative data, if available. The planned data outage may be postponed in the event of significant space weather.

Solar Activity: Moderate with several M-class flares observed. The largest observed reaching M3.4 at 21/2152 UTC from AR3638 in the southwest. There are fourteen sunspot regions on the visible side of the solar disc. This includes a broad complex across the southwestern disc, comprised of AR3638/45/47/43, and forms the main flare risk, despite their individual relative simplicity. This is due to an overarching magnetic structure connecting all the spots, as evidence on SDO imagery, along with some mixing of the magnetic polarities. These regions have shown some ongoing development, but any areal growth remains minimal with AR3643 showing recent signs of decay. AR3639 in the northwest is also moderately sized, but remains stable with a simple bi-polar configuration. The most rapid growth was observed in AR3652 and AR3646 on the northeast disc, although these also remain simple and stable bi-polar regions. Areas of flux emergence and subsequent spot growth also occurred on the southeast disc, however these spots remain small and simple. The numerous filaments appear relatively stable currently. The M-class flares of AR3638 resulted in further weak and apparently southward directed CMEs, which may give glancing blows to the Earth.

Solar Wind / Geomagnetic Activity: Ongoing high speed stream influence from CH25/- continued through the period with solar winds observed by ACE at L1 to be slightly elevated throughout, between 420-480 km/s, albeit rather noisy to observe due to the below average density of the wind. Interplanetary Magnetic Field (IMF) Bt, was weak 3-8nT, with the north-south component, Bz, weakly negative (southward) for much of the period with minimum -6nT at 21/1706 UTC. Brief northward periods resulted in a maximum of 6nT. Phi angle was predominately negative (towards the Sun). Geomagnetic activity was Quiet to Active (Kp2-4).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES18 was at Background. High energy electron flux (greater than 2MeV) observed at GOES16 was initially at Background, but rose to give a period of Moderate 21/1300-1900 UTC with peak 755 pfu at 21/1415 UTC. The associated 24-hour fluence remained below Active (1e8 integrated flux), but with a rising trend, reaching 8.55e6 integrated pfu at 22/0000 UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Occasional M-class flares are expected to continue, with a slight chance of isolated X-class flares. The greatest risk of these coming from the sunspot region in the larger complex of sunspots in the southwest.

Solar Wind / Geomagnetic Activity: There are several CMEs that are anticipated to pass close to the Earth through the period, with potential of glancing interactions. This gives low confidence to the detail for the geomagnetic forecast. Slightly elevated solar winds resulting from CH25/- are expected to gradually decline towards slow-ambient levels in coming days. Quiet to Unsettled geomagnetic activity at first is forecast to become mainly Quiet with isolated Unsettled intervals by day 2 (23 Apr). Any CME arrivals however, will give a chance of further isolated Active intervals and a slight chance of briefly reaching G1 Minor Storm.

Energetic Particles / Solar Radiation: High energy proton flux is expected to be at background, but with a chance of rising in response to any large flares that occur, predominately from the complex of sunspots in the southwest. This bringing a slight chance of reaching the S1 Minor Radiation Storm threshold. High energy electron flux as observed by GOES16 is expected to display a rising trend, reaching Moderate and probably briefly peaking at High diurnal values, however this may be limited by any glancing CME impacts that occur. The associated 24-hour electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold but with an increasing trend, giving a chance of reaching the Active threshold by days 3-4 (24-25 Apr).

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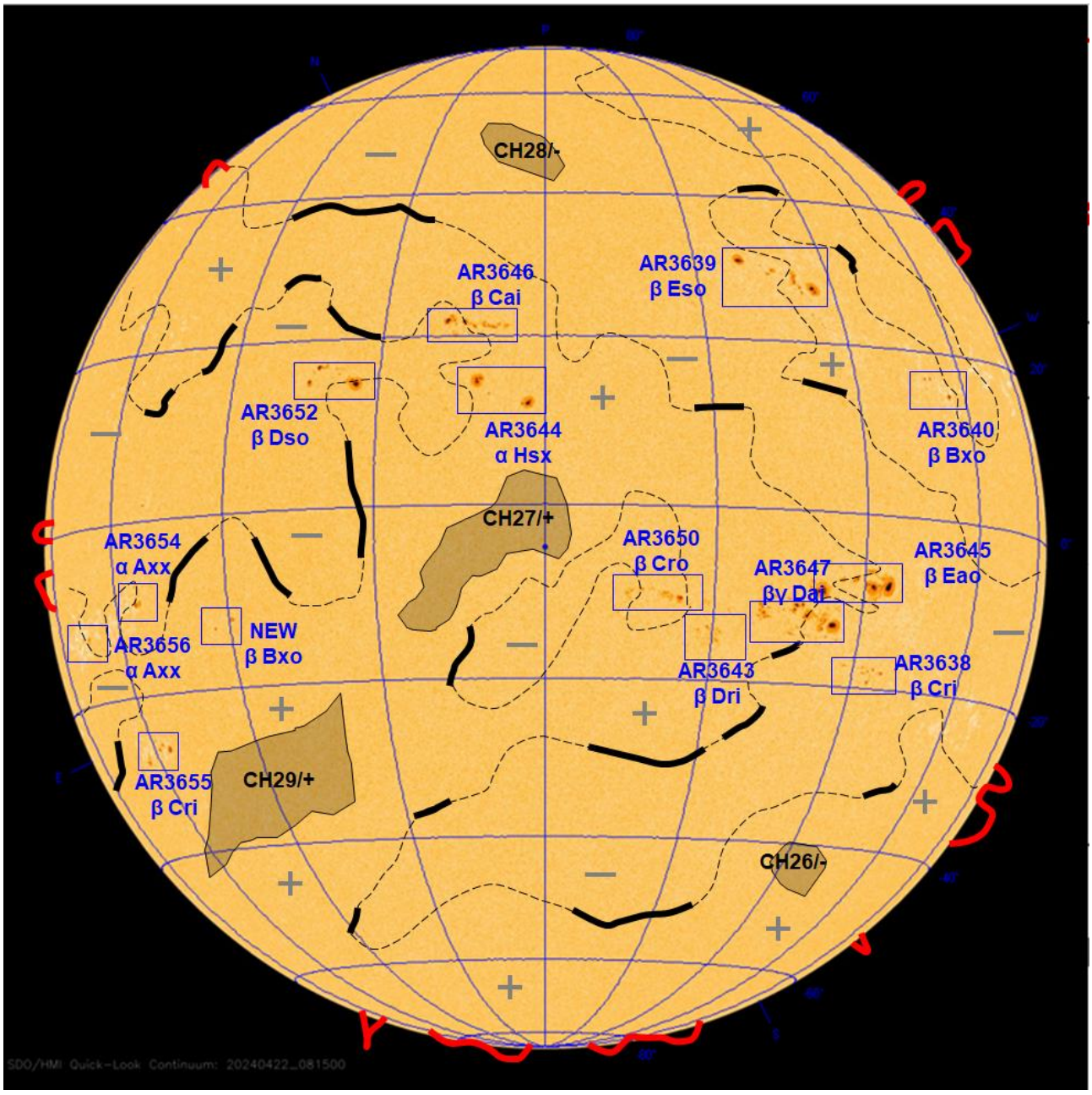
Figure 1. Solar Analysis Valid 0800 UTC, 22 April 2024.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Several CMEs have been carefully analysed and from model expectations are likely to pass close to Earth, and while many will probably miss the earth by passing to the south, or be too weak for much of a noticeable impact, there is the potential for an increase in geomagnetic activity from any glances that occur. These are mainly due to the number of weak ejections, primarily from narrow jet like eruptions from AR3638, but also other regions within the southwestern cluster of sunspot. However, it is difficult to isolate any single eruption as the main risk, with this potential continuing through the period.
Solar winds at slightly elevated levels at first, due to the waning connection of CH25/-, but these winds are likely to gradually ease to slow-ambient wind conditions, as supported by MOSWOC Enlil.
Overall, geomagnetic activity starting Quiet to Unsettled at first, but declining to mainly Quiet with isolated Unsettled intervals by day 2 (23 Apr). Any CME arrivals however, will give a chance of further isolated Active intervals and a slight chance of briefly reaching G1 Minor Storm.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	5	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil

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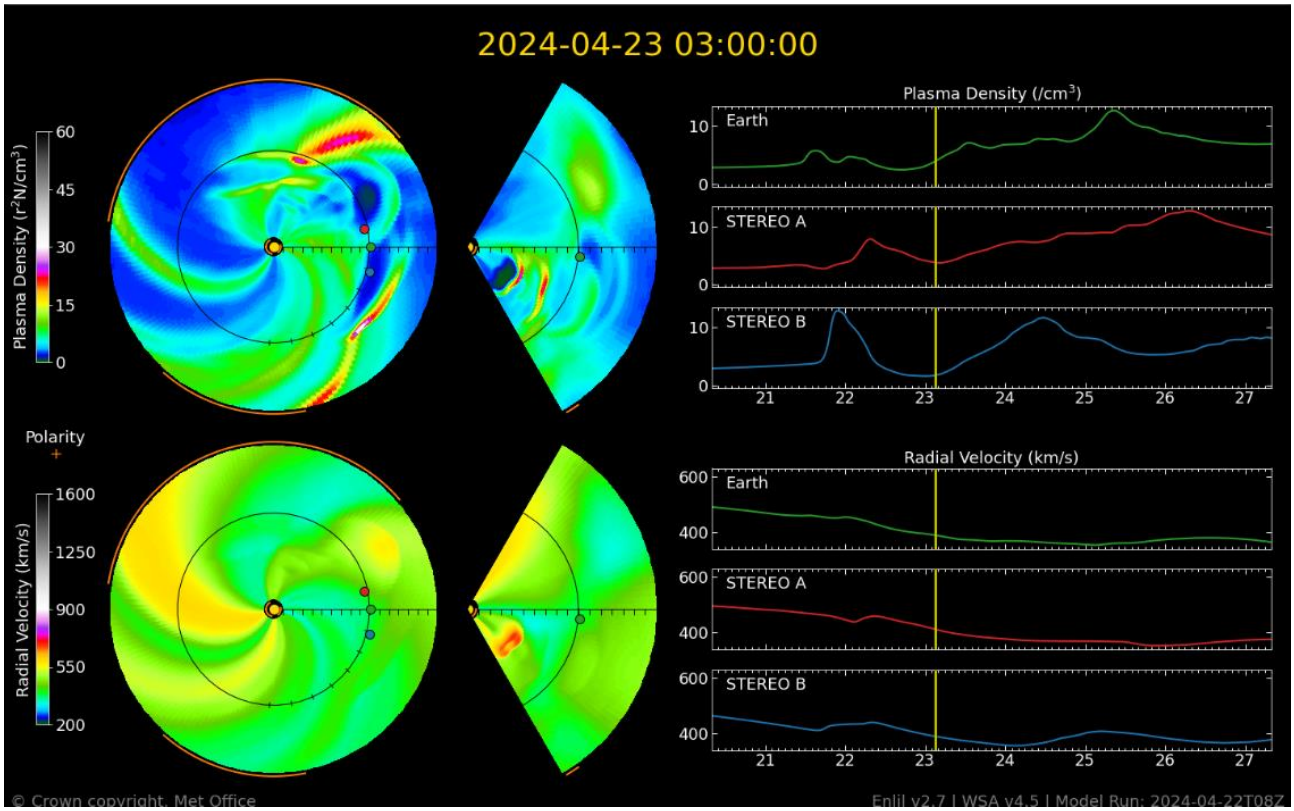
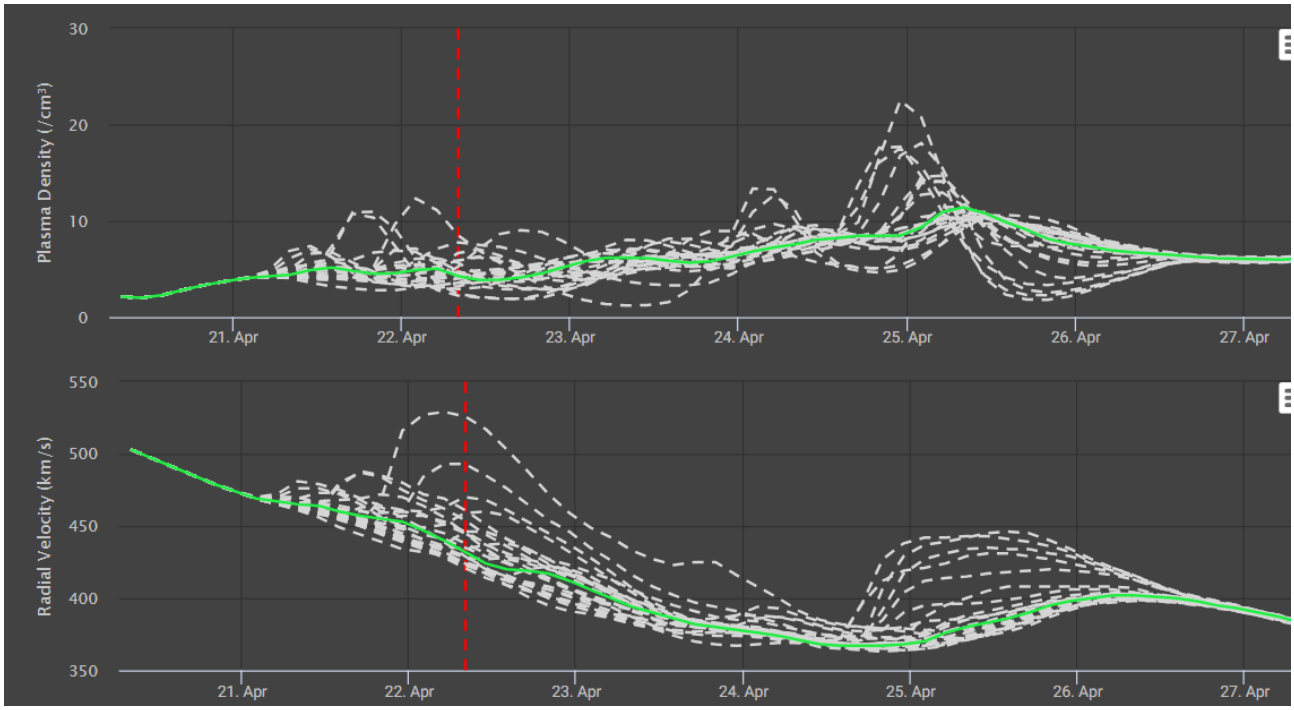
Figure 2: MOSWOC Enlil and ensemble.





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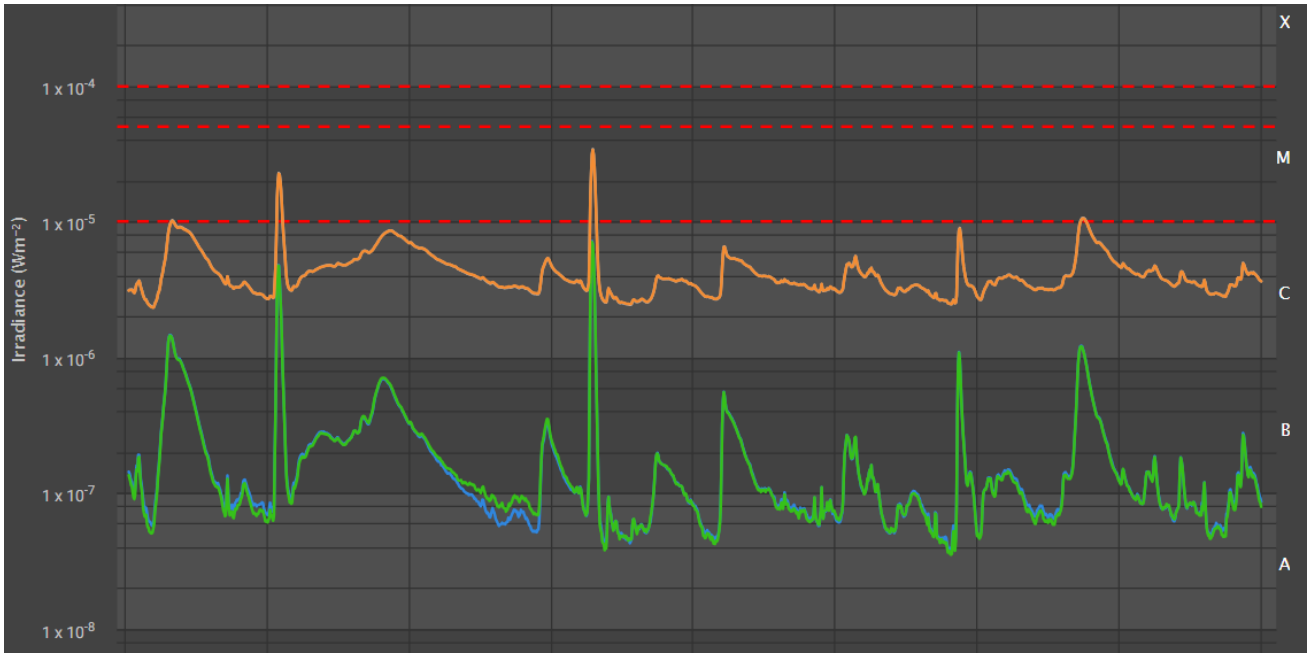
Radio Blackouts - X-Ray Flares:
Moderate activity is expected to continue through this guidance period, with further occasional M-class flares expected and a slight chance of X-class flares.
There are fourteen active regions on the visible disc. This includes a broad complex located across the southwest of the visible disc, including AR3638/45/47/43, which continue to collectively provide the main flare risk, despite their individual relative simplicity. This is due to an overarching magnetic structure connecting all the spots, as evidenced from SDO imagery, along with some mixing of the magnetic polarities, although the majority of recent M-class flares have been from AR3638. This region also includes the main potential for any isolated X-class flares. AR3639 in the northwest is also moderately sized, but appears to be stable with a simple bi-polar configuration. A number of small, simpler spots are also present on the northeast disc, including AR3652 which recently emerged and is showing recent signs of growth. Small areas of flux emergence and spot growth are also visible in the southeast, with a number of new small regions recently numbered.
As well as these active regions a number of filaments are also present and these add to the risk of activity, although the majority appear to be stable currently.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	Yes	80	75	70	60
Very Active	**R3 to R5 X Class**	No	15	15	10	5

Figure 3: GOES-16/18 X-ray Flux, showing several M-class flares in past 24 hours.



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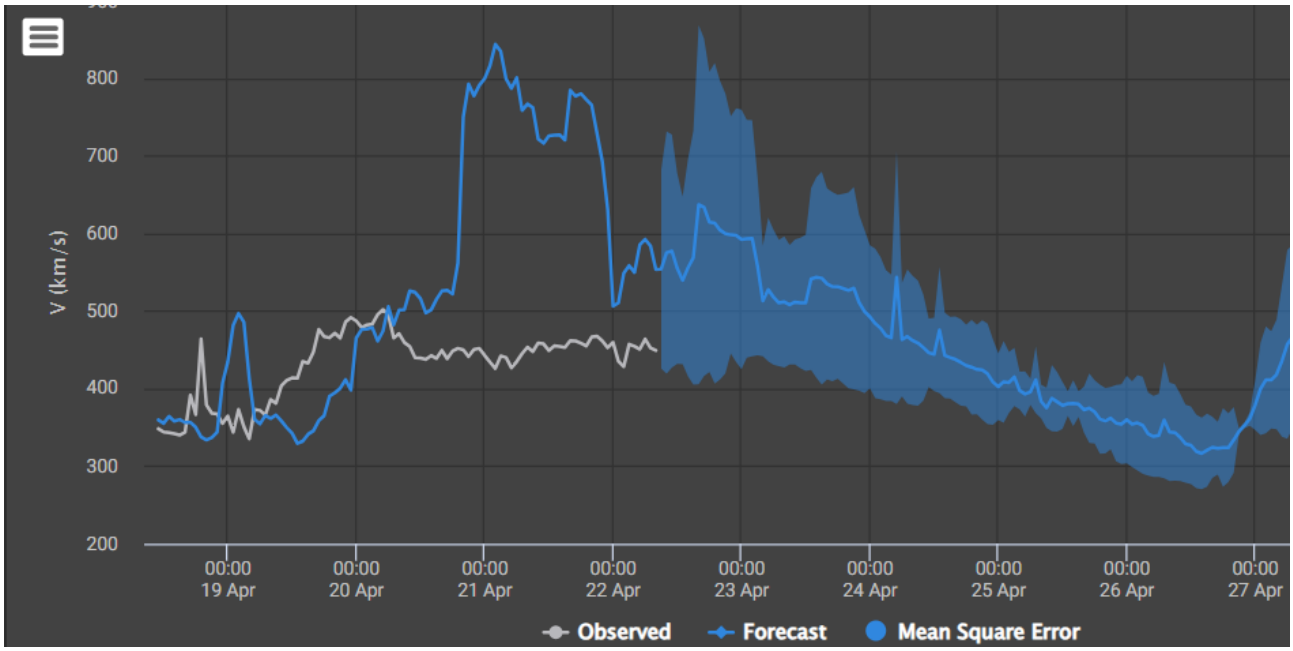
Solar Radiation Storms - (High Energy Protons):
High energy proton flux as observed by GOES18 has persisted at Background. There remains a slight chance of enhanced flare activity, primarily from the cluster of sunspot in the southwest disc, which could increase the proton flux at Earth. This bring a slight chance of reaching the S1 Minor Solar Radiation Storm level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Met Office Solar Wind Prediction Model (SWPM) showing likely decline of solar winds.



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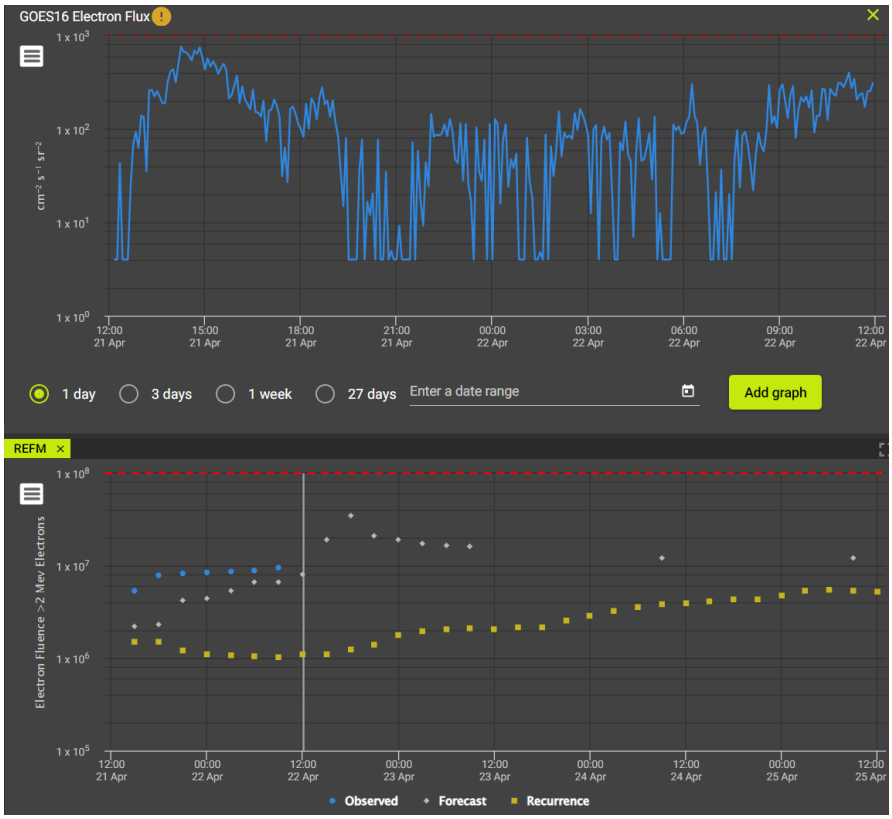
High Energy Electrons Event (≥ 2MeV):
High energy electron flux as observed by GOES16 rose from persistent Background to brief Moderate levels during 21 Apr, as a result of the recent CME arrival and CH HSS onset that had been observed on the previous days. As solar winds ease, any charging that has occurred at lower orbits is expected to become increasingly relevant at GEO, with the observed flux probably rising to Moderate levels and likely peaking at High for a brief period at diurnal maxima. This is only moderate confidence however, as the arrival of any CMEs may help to modulate the observed flux, and any more notable arrivals have the potential to drop values back towards background.
The associated 24 hour electron fluence is expected to continue on an upward trend, as indicated by Met Office REFM output, which is giving a good guide in the absence of any CME arrivals, but perhaps under-estimating peak values a little. This will give a slight, but increasing chance of reaching the Active threshold by day 3 (24 Apr), although this potential will reduce should any dropout from any CME arrival occur.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	25	25
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES-16 Electron Flux and associated 24 hr fluence with REFM



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